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Oversight News

Newsletter of the Commonwealth's Environmental Oversight of the Paducah Gaseous Diffusion Plant

Groundwater Programs Valuable to State's Oversight

Negotiations are under way to renew the Agreement In Principle (AIP) between the U.S. Department of Energy (DOE) and the Commonwealth of Kentucky. Although the AIP formally expired on December 31, 2001, DOE has extended the state's funding until May 31, 2002. Kentucky officials, meanwhile, continue to emphasize the importance of the agreement's mission—independent oversight of DOE's environmental cleanup at its Paducah site.

The AIP's goal is to protect human health and the environment by maintaining an independent, impartial and qualified assessment of the potential environmental impacts of present and future DOE activities at the Paducah Gaseous Diffusion Plant (PGDP). The AIP funds a variety of the state's nonregulatory activities at the plant, from radiological air monitoring to biological monitoring of wildlife near the plant.

This agreement, first signed in 1991, designates Kentucky's Natural Resources and Environmental Protection Cabinet as the lead environmental agency for oversight and emergency response activities at the PGDP and recognizes the authority of the state's Cabinet for Health Services over all radiation issues outside the plant's main security fence.

For more than ten years, several groundwater programs have served an important role in the state's environmental oversight activities under the AIP.

A typical monitoring well at the Paducah plant. DOE has installed more than 300 wells at the site to assess groundwater quality. *Photo by* **Lauren McDonald**, *Ky. Division of Waste Management*

The Kentucky Division of Waste Management has a full-time staff member dedicated to overseeing the DOE groundwater sampling program. Additional AIP staff and a University of Kentucky

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Innovative Technology to Be Used at Paducah Site

A promising technology that uses electricity to heat contaminated soils has been selected for use at the Paducah Gaseous Diffusion Plant (PGDP). Six-Phase Heating technology has been used successfully at many sites around the country to remove Dense Non-Aqueous Phase Liquid (DNAPL)—such as trichloroethene, or TCE—from soils, thus preventing this

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Will Faults Factor into Landfill Decision?

As planned, DOE conducted a series of seismic investigations in and around the Paducah Gaseous Diffusion Plant (PGDP), primarily from November 2001 to February 2002. These investigations gathered information for use in siting, designing and assessing the feasibility of the proposed "CERCLA cell."

If constructed, the cell will be an on-site landfill designed to contain waste generated from PGDP cleanup activities. The proposed location, Site 3A, is located south of the plant's security fence just off Hobbs Road (for more information, see the article, "Seismic Studies to Contribute to Decision on Proposed Landfill," *Oversight News*, October 2001).

The first significant investigation at Site 3A was a p-wave seismic reflection survey. The survey successfully distinguished various geologic features in the upper 200 feet or so of the bedrock and in all but the uppermost sections of the 300 feet or so of unconsolidated material overlying the bedrock.

DOE contractors use a rotosonic drill to collect geotechnical data at Site 3A.
Photo by **Lauren McDonald**, *Ky. Division of Waste Management*

Data from Site 3A was interpreted to identify a network of 11 faults, oriented roughly parallel to one another, generally in a north-south or northeast-southwest direction. Although there was some debate among project team members as to the actuality and the exact orientation of some of the faults, it was agreed to continue the investigation with a shear wave survey in two selected areas of Site 3A. This survey was designed to bring better resolution to those faults that appeared to come closest to the ground surface. At press time, the results from the shear wave survey had not been finalized. Many geotechnical investigations were also conducted on the soils at Site 3A.

A series of investigations was also conducted at Barnes Creek in southern Illinois. This area was already known for having many faults exposed in the stream banks. The most prominent fault exposures were scraped clean so the sequence of the various faulting and deposition events could be observed. All of the exposed faults appear to end at the top of a gravel zone known locally as the Metropolis Formation.

Fred Snider, a consultant to DOE contractor SAIC, discusses faulting visible along the banks of Barnes Creek.
Photo by **Todd Mullins**, *Ky. Division of Waste Management*

This unit was deposited approximately two million years ago. It is hoped that carbon-14 dating will be able to determine the age of the overlying unfaulted sediments. If so, this information will be used to establish the youngest possible age of the observed faults.

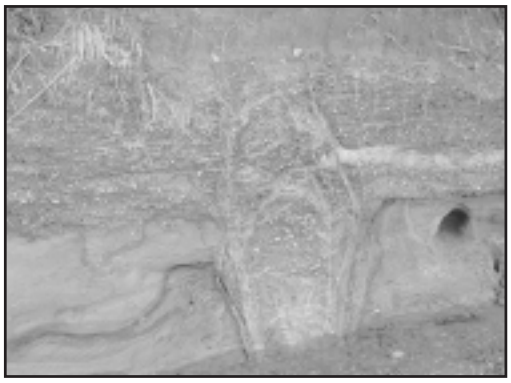
Knowing the age of the local faults could warrant adjustment of the expected local ground motion in future earthquakes. This motion, peak ground acceleration, is a key variable used by geotechnical engineers when designing a structure to withstand a specific-magnitude earthquake in a specific area.

In addition to the investigations at Site 3A and Barnes Creek, a field survey was conducted throughout the region to locate any possible liquefaction features. Such features are generally created only during major earthquakes in sandy, near-surface soils. These features are often preserved in the geologic record as sand dikes or

sand lenses. Understanding the degree of liquefaction that has occurred locally could affect the design requirements for the landfill. Preliminary results indicate that only a few potential liquefaction features exist in the region.

The preliminary results of the seismic investigations seem to agree with the findings from many other seismic investigations conducted in the region over the years—that liquefaction features are rare and that the observable faults are more than 12,000 years old.

By **Brian Baker**, *Ky. Division of Waste Management, Hazardous Waste Branch*



Fault exposures were scraped clean to aid viewing. *Photo by* **Todd Mullins**, *Ky. Division of Waste Management*

Lasagna™ Appears Successful at SWMU 91

On February 21, 2002, DOE submitted a draft "Verification Sampling and Analysis Plan" for the Phase IIb remediation work at Solid Waste Management Unit (SWMU) 91, the former cylinder drop test area. After 20 months of operation, preliminary indications are that the Lasagna™ remediation system has been effective at achieving the cleanup goal for this area, reducing the trichloroethene levels in the soils to an average of less than 5.6 parts per million.

DOE's plan calls for collecting and analyzing 88 soil samples. If the resources are available, the Division of Waste Management intends to split samples and have them analyzed by an independent laboratory. The division expects to approve the plan in March, and the sampling activities will likely occur by June. If the sampling results confirm that the cleanup objective has been met, no further action will be required at SWMU 91.

Although the system appears to have been effective, it is unlikely to be used anywhere else at the site. Lasagna™

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Groundwater Programs

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professor assist with parts of the division's AIP groundwater monitoring program.

How the AIP works to monitor groundwater

- **Water Policy Box ongoing investigation.** DOE currently provides municipal water service to at least 100 residences and businesses inside the Water Policy Box, an area affected by the major groundwater plumes at the PGDP. AIP staff monitor the leading edges of the groundwater plumes to ensure that the existing water policy boundary protects groundwater users outside the Water Policy Box from using contaminated groundwater. Kentucky reviews DOE's five-year plans and identifies potential shortcomings of DOE's monitoring strategies.

- **Responding to citizens' requests concerning groundwater issues.** AIP staff speak with, assist and provide information to concerned citizens. If certain criteria are met, the state will sample residential groundwater wells.

- **Continually evaluating DOE's groundwater sampling program.** DOE is required to maintain groundwater monitoring systems for its permitted landfills and for contaminant plumes. Kentucky AIP staff routinely split groundwater samples with DOE to ensure that results from the independent laboratory used by the state agree with results reported by the DOE-contracted laboratory. Kentucky also augments portions of DOE's groundwater sampling events by independently sampling at additional locations to get a more complete "snapshot" of current conditions. AIP staff recommend changes to DOE's standard operating procedures and sampling techniques when necessary.

- **Groundwater Well Integrity Program.** Problems with a well's integrity can affect the accuracy of sample results. These problems include deterioration or corrosion of a well casing (causing holes or leaks) and bacterial growth that clogs a well. Recognizing a need for more information, AIP staff are currently developing a program to independently assess the structural integrity of residential and monitoring wells being sampled at the PGDP.

- **Groundwater cleanup technologies.** AIP staff assist in the evaluation of cleanup technologies for groundwater contaminants found at the PGDP.

- **Evaluating DOE's groundwater modeling efforts.** AIP staff participate in quarterly modeling meetings and assist with independent reviews of DOE's existing model of groundwater flow in the area of the PGDP. The model helps track and predict the growth of the contaminant plumes and visualize the effectiveness of the groundwater treatment systems.

- **The Water Budget.** AIP staff assessed and communicated the need for DOE to compile a comprehensive water budget, an inventory of all water systems that enter (e.g., through the plant's water lines, etc.) or leave (e.g., through wastewater and steam discharges and losses by evaporation or water line leaks, etc.) the facility. A water budget is needed to ensure the accuracy of the site's groundwater model. A water budget would also help ensure that contaminant plumes do not bypass the expensive systems built to treat them. Some of the water losses from the plant are believed to influence groundwater flow. A change in the magnitude of water losses— from the plant's shutdown, for example— is likely to alter groundwater flow significantly and cause a shift in the flow direction of contaminant plumes.

- **Oversight of University of Kentucky Research.** Several groundwater research projects are in progress at UK under AIP-funded contracts with the state. These projects include:
  - An investigation of springs from which the Northwest Groundwater Plume is discharging into Little Bayou Creek.
  - Lab experiments to learn how TCE behaves in soils and sediments collected from around the PGDP. The experiments are measuring whether TCE is likely to be broken down or taken up by the soils.

By **Brian Begley**, *Ky. Division of Waste Management, Hazardous Waste Branch*

Passive Diffusion Bag Sampling: More Data from Paducah Groundwater?

A current Agreement In Principle project involves developing an alternative groundwater sampling plan that assesses the practicality of using passive diffusion bag sampling. This groundwater sampling technique may lower costs and improve efficiency compared to traditional methods.

With this method, several diffusible membranes are left inside a groundwater well for a period of time. At first, concentrations of volatile organic compounds (VOCs), which include TCE, in the aquifer water surrounding the sampler are high compared to the contaminant-free environment inside the sampler. This difference in concentration causes the VOCs to diffuse into the sampler until the concentration gradient between the aquifer water and the sampler reaches equilibrium. The samplers are then analyzed to find out where the highest zone of contamination occurs.

Currently, most wells at the Paducah plant are sampled at one depth in the aquifer. Because the diffusion bag samplers are relatively inexpensive, several can be placed into each well at different depths. Sampling each well at multiple depths yields a more complete, three-dimensional picture of groundwater quality. It also increases the chances of detecting contamination, if present, especially in outlying areas where wells are far apart from each other.

Innovative Technology to Be Used

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contamination from continuing to enter the groundwater.

Being heavier than water, TCE DNAPL typically sinks after being spilled onto the ground or released into subsurface soils. As it sinks, the DNAPL leaves residual traces of itself in the shallower soils. Eventually, the DNAPL reaches a relatively impermeable geologic unit and begins to pool at the top of that unit. If enough DNAPL collects in a particular location, its weight may allow it to continue into deeper units. This has occurred at the PGDP. At Paducah, DNAPL is thought to be located within the shallower Upper Continental deposits as well as at the bottom of the Regional Gravel Aquifer (RGA). Unless it is removed, the DNAPL will continue to slowly dissolve into the surrounding groundwater, possibly contaminating this resource for several thousand years into the future.

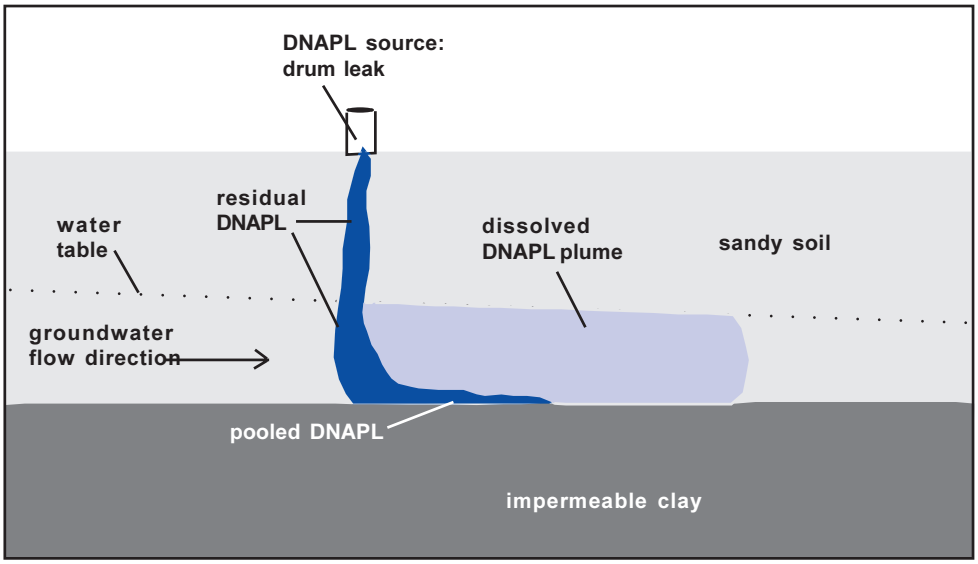
Six-Phase Heating requires the installation of at least seven subsurface electrodes. Six of the electrodes are placed in a hexagonal array to a desired depth into the contaminated soils. As electricity flows between the six hexagonally arranged electrodes and the seventh electrode, TCE-contaminated soil and groundwater is heated, vaporizing the TCE. Vacuum wells extract the vapor, which is then treated before being discharged into the atmosphere. In some instances, Six-Phase Heating has been shown to be more than 90 % effective at removing DNAPL from the subsurface. It also has the advantage of being able to clean up contaminated soils in a relatively short period of time (a few years).

At present, the use of Six-Phase Heating is planned at four sites inside the PGDP security fence. The technology has been selected to clean up contaminated soils at Solid Waste Management Unit (SWMU) 1 (the C-747-C Oil Landfarm) and at the C-720 Building. A single area within the Upper Continental deposits will be remediated at SWMU 1. At C-720, Upper Continental deposits at the northeast and southeast corners of the building will be remediated.

In addition, a single electrode array will be installed near the southeast corner of the C-400 Building as a test to determine if Six-Phase Heating can be successfully used in this area. Use of the technology at C-400 presents several logistical and technological challenges that will not be faced at the other three sites. For instance, unlike at SWMU 1 and C-720, the electrodes will be installed into both the Upper Continental deposits and the deeper RGA. Also, the installation will take place in an area that contains a number of buried utilities. If the test is successful, Six-Phase Heating will likely be used to treat the highly contaminated soils near C-400.

By **Todd Mullins**, *Ky. Division of Waste Management, Hazardous Waste Branch*

How DNAPL travels in soil and groundwater



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is generally only warranted when there is organic contamination in clay soils and where there is unobstructed access to the contaminated zones.

By **Brian Baker**, *Ky. Division of Waste Management, Hazardous Waste Branch*

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